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The Prime Movers of Historical Change

Dr. Robert C. McWilliam, MSc, MBA, PhD, CEng, MICE, FIES, FRSA,
Chairman, Editorial Panel, Biographical Dictionary of Civil Engineers &
Technical Secretary, Panel for Historical Engineering Works,
The Institution of Civil Engineers, London, UK

SUMMARY: *This paper is derived from the experience gained to date in producing the third volume of the "Biographical Dictionary of Civil Engineers in Great Britain and Ireland". The period dealt with in this volume is 1890 to 1920. For much of that time Britain had huge foreign investments supported by London-based consulting engineers. The Institution of Civil Engineers served as a learned society for many and an exclusive club for a minority of professional engineers throughout the British sphere of influence. The exclusive club promoted the concept of an empire-wide organisation able to use the services. The club organised "their" Institution to reflect this and sought alliances with overseas members for this outcome. Beyond the club but within the British Isles were more than half the membership of the Institution, who had little to do with the elites in Westminster, but shared some beliefs in a club of which they were part of an outer circle. To demonstrate the way the careers of such engineers developed a detailed case-study is given. It shows how one engineer, Thomas Aitken (1856-1918), fared.*

1. INTRODUCTION

"A Historian …. has to understand the minute variances that are the prime movers of historical change: the choices an individual can make, from the identical background as everyone around him, to crave something….entirely different from the "popular" choice." (1)

Emerson's dictum that "all history is biography" can be interpreted in various ways from the "great man approach to history" to ensuring that no individual is forgotten. The use of biography in the study of entrepreneurship has developed a pedigree in certain schools of business (2). It has been used to re-interpret events in varied industrial and commercial settings (3). There are some shared attributes of entrepreneurs and engineers (4).

2. THE PROJECT

A small group of volunteers supported by the Institution of Civil Engineers in London are continuing work on a project on the lives and works of civil engineers in a series of volumes whose full title is "A Biographical Dictionary of Civil Engineers in Great Britain and Ireland". Two volumes have already been published: Volume 1 (1500 to 1830) in 2002 and Volume 2 (1830 to 1890) in 2008 (5, 6). Work has embarked on a third volume intended to cover the period from 1890 to 1920. It is intended as far as possible to retain the style of the earlier volumes, but changes are required to reflect the period selected for the third volume. It is tempting to assign the movement of engineering change to the more complex organisations that were being established, but the more effort that is put into unscrambling the role of individuals from the organisational structure built around them the more often an individual's contribution can be identified.

Few of the individuals named in these Dictionaries are to be found in other reference books. An interim list for Volume 3 has 1000 potential entries. A significant minority, but less than a 100, of these possible entries have been published in the "Oxford Dictionary of National Biography", which succeeded the century old "Dictionary of National Biography" as the national pantheon in 2004. Its initial 60 printed volumes are now becoming a smaller proportion of an increasing number of on-line entries, which may never be offered in print (7). Engineering biography has different priorities from either the study of entrepreneurs or the selection of individuals for a national pantheon. These priorities partly arise from the long life of many civil engineering works. This heritage makes it useful to both identify the major works of the entries and to establish the identities of their trainees. It is likely that trainees would be influenced by, if not follow, their mentor's approach to design in their own works. This is particularly important for works built before 1920 as design procedures had not begun to be standardised until the Great War (8). Until then it had been the opinion of the Institution of Civil Engineers that such matters as, say, the loads to be borne by new bridges were the individual decision of their designers and need not be the subject of any national consensus (9).

3. THE PERIOD

During the period from 1890 until 1920 there were many subtle changes in the employment of civil engineers world-wide and of the significance of the Institution of Civil Engineers. It was the leading engineering society in Britain and was the model often followed by other similar bodies in both the United Kingdom and elsewhere. More new members joined the Institution in those thirty years than in all the previous years combined since its formation in 1818. The Institution of Civil Engineers is a hierarchical organisation. At that time there were three main categories of member. Students were trainees of between eighteen and twenty-six who were or had been pupils of a corporate member. The largest group were Associate Members who were over twenty-five years old, who had both been educated as civil engineers and been engaged in civil engineering work for at least five years. The third main class was Members who were over the age of thirty who had been employed as a resident engineer or equivalent for at least five years. Above these three layers was the select group of Members of Council. The Council expressed the Institution's official opinions as well as governed its operations and finances.

After 1890 Britain's distinctive commercial feature was not its manufacturing districts, which were individually challenged elsewhere. It was Britain's huge foreign investments that were different (10). The largest proportion of this investment was in mining, which had almost a third, but more than half of the remainder was initiated by civil engineering of railways, tramways, water supply, sewerage systems, etc. The head offices of many of these organisations were in London and their consulting engineers were there too. These were the figures that came to dominate the Council of the Institution of Civil Engineers which sat at the centre of a network that radiated far beyond its headquarters in Great George Street, Westminster.

4. BRITISH INFLUENCE

The Institution had overseas members from almost its start. Corresponding or Non–Resident Members included all members living more than ten miles from Westminster. By 1896 most of the ICE's membership had addresses more than ten miles from Westminster. Half the entire membership lived elsewhere in the British Isles. More than half the remaining members were overseas, almost all in the British sphere of influence, i.e. India, Australasia, Canada and the colonies. The ICE was more than an international learned society it was also a London club for professional engineers. The Council was dominated by London-based consulting engineers. By the 1890s they had identified their own future with the growth of the British Empire and they saw centralised control from London as their key concern (11). When the ICE headquarters building was rebuilt in 1910 its imperial significance and identity was emphasised in the materials used for its construction which came from all corners of the Empire. It was intended to be as much a part of imperial Westminster as the nearby Colonial, Foreign and India Offices.

The control sought by the Great George Street clique was not easily achieved. The overseas members expected some say in matters. They sought to influence the Institution so that their needs and requirements were addressed. They pushed for representation of specific expatriate constituencies on the ICE Council and for the setting up of local Advisory Committees. The small and highly influential group of Westminster-based consultants made concessions in order to retain and develop their connections with the diaspora of British engineers as people who could be called on with strong ties of friendship and obligation to help maintain their own power and authority. This imperialist view withstood and was perhaps reinforced by the trauma of the Great War. In the war's aftermath the leading ICE members would allow the number of their lost sons to be offered as a reminder of their commitment to an imperial vision. Less committed outsiders saw that the independent dominions would become increasingly so - no matter how much wishful-thinking was undertaken and minor concessions were offered in London (12).

5. ENGINEERING OBITUARIES

During the era covered by Volume 2 it was possible for a Civil Engineer to both be innovative in Engineering Science and make an impact in practical business at the same time (13). By the time considered in Volume 3 some early engineering researchers did move on to business, but only a small minority could be classed as innovators. Specialisation and segmentation around maturing technologies were the main trends of civil engineering - with only a few exceptions - in the period. The period covered by the third volume deals with the increasing scale, complexity and specialisation of British civil engineering endeavours. Civil engineers, whose birthplace, education and formative years in the profession were abroad, sometimes relocated to the United Kingdom. All of Ireland was part of the United Kingdom during the period before the creation of the Free State in 1922. Herbert Hoover, later to be a President of the United States was based in London from 1900 until 1917 as a consultant mining engineer.

Membership of the Institution of Civil Engineers is not a prerequisite for entry into the Biographical Dictionary of Civil Engineers, but the membership doubled over the thirty years under review and many of those members are worthy of at least a short mention. The current public interest in genealogy implies that the more individuals researched the better –

especially if, at some future date, it is decided to follow the lead from Oxford and increase the number of entries available on line. Obituaries published in the Minutes of Proceedings reduced dramatically in number during the Great War and as a result this valuable starting–point, which had been available for the two earlier volumes, is not available for many potential entries. On the other hand in the twentieth century there was much more contemporary commercial publication, some of which identifies individual responsibility while others include conflicting claims which need careful scrutiny.

6. ENGINEERING SCIENCE

Most pre–1920 civil engineers did not have university degrees, but academic awareness and theoretical analyses were increasing. This was the first period when engineering professors with full academic careers became ICE Presidents. There was an increased promulgation of engineering science through teaching and texts – a large increase in the publication of handbooks, such as the annual Kempe's, and the emergence of technical standards as part of a wider change in societal infrastructure. This included a wider use of more rigorous testing and the beginning of government sponsorship of central laboratories. The first of these, the National Physical Laboratory, was controlled by the Royal Society with the support of, *inter alia*, the ICE. In 1916 the government set up the Department of Scientific and Industrial Research with a mandate to conduct research on subjects which concerned the community including building and encourage research by industry through research associations and the training of researchers in universities. Many ICE members were to participate in these activities.

These new approaches followed the introduction of new 'scientific' materials and their large scale exploitation. 1890 marked the completion of the Forth Railway Bridge. This project appears in the careers of several potential entries for Volume 3 including Sir William Arrol, Sir Benjamin Baker, A.S. Biggart, Adam Hunter, R.E. Middleton, Sir Ernest Moir, Wilhelm Westhofen, J.E. Tuit, while some, including Allan Duncan Stewart, Sir John Fowler and Sir William Siemens, whose steel was credited at the time with making it possible, were covered in Volume 2. After 1890 rolled steel sections became civil engineer's most used metal structural component. Another civil engineering use of steel was as reinforcement in association with Portland cement, which became the second most used processed material after treated water throughout the twentieth century. The use of concrete and steel in building, the traditional enclave of the architect, was to be a stumbling block for the ICE's Council. In 1900 Royal Institute of British Architects requested the ICE's opinion on collaboration 'in design of certain classes of structure', the ICE response was that 'the practice of the Institution of acting independently in matters within its scope rendered it inadvisable for them to meet the wishes of RIBA in this matter' (14). This attitude led to the establishment of the Concrete Institute and its successor the Institution of Structural Engineers, whose formation was another example of the "institutional proliferation in the British Engineering Profession" (15). The extensive shared interests and personalities in concrete and steel technology result in all structural engineering activities being treated as part of civil engineering in the Biographical Dictionary.

7. LARGE SCALE WORKS

Concrete and steel were also the materials that were to 'scale up the man–made world'. Larger docks and deeper navigation channels were required for much larger merchant ships as well as larger warships in the naval race before 1914. These were complemented by rebuilding British railways for heavier and faster trains as well as more challenging bridge crossings. A whole range of civil engineering techniques began to be developed or transferred from the mining industry to deal with new problems that were to arise in soil mechanics, foundations and temporary works. The organisation of work especially the large–scale munitions projects required for the Great War was to tax many engineers and introduce more of them to the larger–scale of the process industries that marked the twentieth century.

Before the Great War the majority of Britain's huge foreign direct investments in railways, seaports, tramways, etc., employed civil engineers both as home–based consultants and overseas. There, especially in the British sphere of influence, bigger cities worldwide required large–scale utilities often financed by British capital. This extended beyond flood–control, water–supply, sewerage and town–gas, and included centralised electricity generation and distribution. The bulk of the infrastructure for the electric tramways was completed both abroad and in the UK during this period. Another device that began to impact on civil engineering was the motor car. Much was written about the 'dust nuisance' after the dry summer of 1905 and the techniques used to seal traditional road surfaces.

8. WIDER INTERESTS

The larger scale of heavy engineering projects after 1890 encouraged many distinguished engineers whose core discipline was not or had ceased to be civil engineering to both contribute to the ICE and could often be Members of Council. Many of these names appear in the "Oxford Dictionary of National Biography". There are at least 120 whose entry refers to the ICE, but whose interesting lives do not include civil engineering works. The number of marine

engineers and naval architects appears remarkable with Sir Alfred Yarrow, Sir William White, Sir Phillip Watts, Sir John Thornycroft, Francis Elgar, Summers Hunter, Sir Henry Oram and Sir Archibald Denny highly placed in ICE's Council. A similar situation occurs with electrical engineers, such as Sir William Preece, M.H.P.R. Sankey, Sir John Snell and, perhaps more surprisingly, locomotive engineers, such as Sir John Aspinall, J.M. Dobson, F.W. Webb, as well as mechanical and steel industry specialists, such as Sir Hay Donaldson, Sir Robert Hadfield, W.H. Maw, Sir Andrew Noble, Sir Charles Parsons, and W.C. Unwin.

Also in this period municipal engineering was evolving from its origins in sanitary science to deal with the problems arising from rapid urban growth. The term "municipal enterprise" was coined. Municipal and County Engineers expanded their activities to include public housing, paving of streets and latterly the construction of new urban roads. This branch of civil engineering introduced techniques, which later became the prerogative of the autonomous town planning profession. Their impact on urban development in the twentieth century was extensive. The successor body for these cross-disciplinary municipal engineers was the Institution of Municipal Engineers, which merged with the Institution of Civil Engineers in 1984, but its heyday was the early 20th. century.

9. ANOTHER GENERATION

The culture of the profession changed within that period and potential conflicts of interest became a greater concern to the public and members. The older members of the civil engineering profession fought a rear–guard action against this. Matters came to a head in 1911 when the 'young Turks' within ICE sought to establish what was to become the Association of Consulting Engineers (16). The group placed the aims and objects of the Association before ICE's Council and a deputation consisting of A.H. Dykes, L.R. Lowcock, W.M. Mordey, J.F.C. Snell and James Swinburne were subject to questions.

The result was an open letter from the Institution of Civil Engineers which questioned the need for a distinction between a 'Civil Engineer' and a 'Consulting Engineer'. The Council's main concern was that the Association would not accept anyone with a concurrent official position and this could in time 'exclude from advisory and consultative work engineers who hold official positions….' whose experience may specially qualify them to give advice on matters with which they are conversant, would be an injustice to them and a serious loss to the public interest' (17). While the Association was concerned about competition for professional engineering work by persons who gained 'their principal emoluments from their commercial or manufacturing interests, and are on that account content to take low fees from consulting work'. ICE's Council formally informed the Board of Trade that they regarded the Association's exclusivity as "a serious loss to the public interest" when the Association of Consulting Engineers sought registration in 1912.

10. THE CASE STUDY

Many such ambiguities and potential conflicts of interest seemed to have been tolerated through much of the period. Individual biographies bring out interesting examples. There follows a case study of Thomas Aitken. He was able to have four concurrent careers, serving more than one master, a 'moral hazard' – but a very effective way of transferring technology.

He had published in engineering journals, including Minutes of Proceedings of the Institution of Civil Engineers in the 1890s, and wrote, probably the best British–published highway engineering book until Collins & Hart in 1936, "Road Making and Maintenance" – first edition in 1900, second in 1907, with an unpublished third edition at the time of his death. He achieved international fame on winning the 1907 Road Improvement Association prize for a pneumatic tar sprayer, which he signed over to a contracting firm, the Taroads Syndicate Ltd of which he was the Managing Director. The fame also led to his services as a consulting engineer most notably to Delaware's duPont family when in 1908 they began to plan a visionary superhighway known as the Coleman duPont Road, along the length of the state.

The Taroads Syndicate gained a reputation of always winning contracts in the county of Fife to the extent that there was no competition for work there. This was hardly surprising as Aitken was the County Road Surveyor and its County Treasurer expressed concern that Aitken alone agreed the quantities of the work undertaken by the Syndicate. When there were complaints at public meetings about the damage to other property by the county's contractors Aitken took the position that the claimant should take the matter with the Syndicate and not the County Council. After Aitken's death in 1918 the next County Surveyor's contract specifically prohibited him from any other paid employment

The whole of Thomas Aitken's life and times is unlikely to be fully told. His surviving writing appears to be either descriptive or promotional. There were no recorded interviews or known diaries. Such information as exists about his life at the beginning of the 20th century arises from the chance survival of correspondence, official archives, newspapers and other publications. It is fortunate that any material survives at all - otherwise another salutary reminder of the

contributions of an individual would be lost and with it the lessons to be learned from their trials and errors and, more importantly, how such engineers did achieve results. At the time people seemed to be satisfied with the roads in his care, and mostly ignored his "conflicts of interest".

The case-study of Thomas Aitken follows as an Annex. It is worth remembering a remark by a one-time mentor, who cautioned that no matter how diligently they are researched the dead can never be fully resurrected.

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Annex A: Case Study
The life and work of Thomas Aitken (1856-1918): an engineer in a developing region.

Dr. Robert C. McWilliam, MSc, MBA, PhD, CEng, MICE, FIES, FRSA,
Chairman, Editorial Panel, Biographical Dictionary of Civil Engineers &
Technical Secretary, Panel for Historical Engineering Works,
The Institution of Civil Engineers, London, UK

SUMMARY OF ANNEX: *This case-study describes the career of Thomas Aitken (1856-1918). He was one of the "silent majority" of British civil engineers, who had little to do with the elites in Westminster with their influential imperial connections. His opportunity to progress four separate careers concurrently was later denied his successor. The case-study demonstrates the complexity of such as Thomas Aitken's life and times whose commercial, political and technical restraints are both different and misleadingly familiar to our own.*

1. INTRODUCTION

Thomas Aitken was born in Edinburgh, Scotland, on 28 February 1856, he was educated at the city's High School and Heriot-Watt College. While at college in 1872 he became an engineering pupil of the North British Railway Company, then Scotland's second largest railway. At the end of his pupilage he became an assistant and then a resident engineer in the northern district of the Company's system, until he was 26 when he was appointed road surveyor of Fife. He was still in that post when he died at the age of 62 on 27 May 1918.

At first sight Aitken's was a simple career, but its longest strand as a paid official was only one of the four strands of a diverse engineering career, which is complex to unravel (1,2). The second strand was as a technical author, which he began at the age of 30 and resulted in texts still in use several decades after his death. His third strand as a consultant began a year later. At the age of 52 Aitken was one of two consulting engineers "of international renown" hired by Coleman duPont, a member of Delaware's leading industrial family, to visit Wilmington to advise on the formation of a visionary superhighway intended to run the length of Delaware, which would be handed over by the family to the state as each ten mile section was completed. The fourth, and nowadays perhaps most surprising, strand began in 1906 when at the age of 50 he became the Managing Director of a road surfacing contractor, which numbered his employers in Fife amongst its customers.

2. THE DEVELOPING REGION

The Fife peninsula lies on Scotland's eastern seaboard. To the north lies the mouth of the River Tay with Dundee on its northern shore. To the south lies the mouth of the River Forth with Edinburgh on its southern shore. Its area is about 1300 square kilometres. The rapid expansion of coal-mining and its supporting industries doubled Fife's population between 1850 and 1900 to over 300,000 (3). Through the 20th century growth continued much more slowly to reach 360,000 of today.

By the late 1850s the peninsula's ports and main centres of population had been linked by a network of local railway schemes that had survived from the many formulated during the 1845 railway mania (4). Few places were more than a dozen kilometres from a railway of sorts. All heavier industry was served by branch railways and from the age of 19 until he was 26 Aitken surveyed, set-out and superintended the construction of short branch lines and tramways to collieries and quarries and latterly superintended additional tracks to the main railways.

Those seven years were momentous times for Fife's railways. In 1879, when Aitken was 23 the newly completed railway viaduct across the estuary of the Tay collapsed. By 1882 work had begun on the replacement for the Tay Bridge and for the even more famous railway bridge across the Forth estuary. At the same time a main east-coast trunk railway line was being formed by upgrading one series of routes between the two major bridges through Fife (5). There is no mention of the large projects in Aitken's papers. In 1882 he did work on a railway bridge across the Forth - but far upstream at Stirling, where a railway line from West Fife added to the collection of bridges beyond the upper limit of navigation. In that year he opted for a seemingly quiet life – but a busy one.

3. THE FIRST STRAND

The busy job was County Road Surveyor. In 1882 the decline of turnpike roads was well advanced as longer distance traffic transferred to the parallel railways (6). The county councils had begun to improve roads for the agricultural and local road traffic which now ran to the railways by the former cross-roads. These cross-roads now led to railway stations. The tempo of development ensured that traffic had very much increased. In the earlier words of a member of Parliament, as railways took over the long distance traffic county roads required to be renewed such that "the veins of traffic (became) arteries, and the arteries veins" (7). Although contractors were sometimes used, the bulk of the manual work in both roads and quarries was undertaken by hourly-paid employees controlled by trusted foremen.

Surviving records indicate that for the first five years of his appointment Aitken concentrated on the tasks before him as a paid official – the first strand of his career. During this time he undertook his most scenic road project, which was also in the best tradition of Thomas Telford's practice (8, 9). His new road ran obliquely down the Garlie Bank, now the A916 south of Cupar, Fife, to "link two valleys to replace a route with gradients as steep as 1 in 10 while saving 1½ miles with a maximum gradient of 1 in 30 suitable for mixed traffic" (horse and traction engine).

4. THE SECOND AND THIRD STRANDS

At the age of 30 he began the second strand of his career - writing what he called "pamphlets" on topics such as masonry bridges and rock-drilling. The third strand of his career as a consulting engineer can be traced to 1887 when he commenced his "concurrent private practice" with a small sewerage scheme for the Burgh of Ladybank.

It was probably with this third strand in mind that he applied for Associate Membership of the Institution of Civil Engineers (ICE) in 1893 at the age of 37. His application made much more of his first ten years with the North British Railway than his subsequent eleven years as a Road Surveyor. His supporters were all from railway organisations (10). Two years later he described his more recent experience in a paper on the maintenance of macadamised roads, which was published in the Minutes of Proceedings of the ICE in 1895 (11).

This seemed to whet his appetite for fully developing the second strand of his career and five years later the first edition of his seminal work was published, "Road Making and Maintenance: a practical treatise for engineers, surveyors, and others with an historical sketch of ancient and modern practice", by the London publisher, Charles Grifffin and Co. Ltd. (12). Griffin was a major publisher then, its extensive catalogue of Standard Engineering Publications included the 20th. edition of "A Manual of Civil Engineering" initiated by Professor William MacQuorn Rankine" – which had been the best established British text to include road-works to date.

Aitken's 456-page text dealt with the issues that concerned county councils, whose responsibilities for highways had increased in scope following administrative changes in the previous decade. In this first edition Aitken described "mixed traffic" as horse and steam traction and dealt with road alignment, bridge - works, stone-breaking and the metalling of roads. Much space was dedicated to the use of machinery for macadamised roadworks. At that time the county councils involvement in macadamised roadworks included local quarrying, stone-breaking, rolling and keeping the surface clean. The latter was important then as bituminous materials were not in routine use. This was soon to change.

Aitken's position in the first strand of his career was enhanced in 1900, when he was elected President of the Road Surveyors' Association of Scotland. In 1902 he also attempted to transfer to senior membership grade of the Institution of Civil Engineers. He failed after re-submitting his 1893 application with brief additions referring to his work in Fife, his being consultancy work for "several County Councils in Scotland and Ireland" and his 456-page book. His list of sponsors had been extended. These now included consulting engineers in Scotland and Ireland, Charles Hogg and Peter Cowan, and the mechanical engineering expert Professor Hele-Shaw, who confirmed the worth of Aitken's book (13). In the following year Aitken re-applied successfully with the additional support of the most important railway engineer in Scotland, Donald Matheson, Engineer-in-Chief and later General Manager of the Caledonian Railway Company (14). Aitken also provided a much more detailed list of both his publications and other works, which included the reconstruction of the main road between Belfast and Lisburn and his detailed planning for one of the last independent railways proposed to be built in Scotland, the un-built Falkland Light Railway.

5. THE FOURTH STRAND

Light railway projects were abandoned as motor vehicles gained popularity. The automobile also enabled Aitken to launch the fourth strand of his career. Motor vehicles brought the "dust problem" to the unsealed roads of Europe during the dry summer of 1905 (15). This problem was addressed by Aitken, who developed a machine to force under

pressure tar or other viscous liquid into the surface of the roads to both "overcome the dust nuisance and at the same time add materially to the life of the road". Aitken's pneumatic tar sprayer was entered for the UK Road Improvement Association's prize at an international competition held near Windsor in England, in 1907.

The Road Improvement Association trials were backed by finance provided by the Royal Automobile Club and the Motor Union. The three chosen stretches of road near Windsor were a four mile stretch of Middlesex County Council macadam road from Baber Bridge to the Staines boundary, two miles of flint road between Twickenham and Kempton, maintained by Staines Rural District Council and three miles of gravel road at Ascot under the control of Berkshire County Council (16). The trials took place during the last week in May 1907.

Three other competitors had brought completed machines to the trial, all of these other machines were failures for one reason or other. Aitken entered one of his patent pneumatic sprayers on a Mann undertype steam wagon. It was the only machine that met the stipulated requirements (17). Aitken gained both a gold medal and a prize of 100 guineas.

Aitken transferred his patent rights to the Taroads Syndicate Ltd. From 1906 until his death Thomas Aitken was listed as manager and representative in Scotland for the Taroads Syndicate Ltd., sometimes known as the Aitken Taroads Syndicate. It was among the first tenants of a new office block completed at 29 St.Vincent Place, Glasgow, for the Scottish Provident Institution in a style described as French Second Empire Renaissance. It continues to be one of the prime commercial buildings in Glasgow (18). In 1906 Glasgow had the highest concentration of British Consulting Engineers outside London.

Then the building housed the offices of several influential Scottish engineers who were pioneers of epoch-changing technologies in the early 20th century. These included John Strain, during the second phase of his career, centred on the Lanarkshire Steel Company, who helped initiate the British Standards movement and the subsequent development of the International Standards Organisation and Albert Richard Brown, whose role as intermediary and guide with his connections in Japan were to influence the industrialisation of the Far East (19, 20).

6. EXPLOITING THE TECHNOLOGY

Aitken's machine was patented not only in Great Britain, but in United States (Patent No. 918,490) as well as France, Germany, the Netherlands, Belgium, Australia, South Africa and other countries. Several of these foreign patents were sold within a few years, while the Taroads Syndicate continued to exploit the technology with plant on his principles sold all over the world. Most machines were on steam wagon chassis, many of them by Mann of Leeds or Aveling & Porter. (21). The last of the Aitken sprayers in Scotland was broken up in the 1950s.

The 1907 trials gave impetus to the tarring of roads and the introduction of mechanical spraying plant for the purpose. When a spraying machine was mounted on a steam wagon steam coils could be used to keep the tar melted, but where bitumen mixes or pure bitumen were used, as happened on a substantial scale from the mid-twenties onward, steam provided insufficient heat and a separate heat source either solid fuel or oil fired had to be provided. Any bitumen boiler, whether equipped with a sprayer or not, needed a double pass flue bringing the chimney to the same end as the firedoor and the furnace was generally larger. In the interwar years a large part of this trade was in the hands of Wm. Weekes & Son Ltd., of Maidstone (17). Their chief designer, Leonard Pearch, bought a map and gazetteer of New Zealand and set himself the target of selling at least one appliance to every road authority in that country – an ambition he did achieve eventually.

7. THE SECOND STRAND - CONTINUED

Also in 1907 the second edition of "Road Making and Maintenance: a practical treatise for engineers, surveyors, and others with an historical sketch of ancient and modern practice", was published by the same London publisher, Charles Grifffin and Co. Ltd. This edition was 540 pages, 84 pages more than the first edition (22). The extra pages dealt with the attributes of motor cars, citing extensively from, *inter alia*, Professor Hele-Shaw's work as well as new chapters on dust prevention and the advances in the analysis of rock for use in road-making.

Shortly before his death Aitken had received the proofs of a large part of a third edition from the same publisher. His books were a source of information for British highway engineers for a surprisingly long time. The people in the north of the Hebridean island of Raasay had no road to link them with the more prosperous south of the island. A petition for a publicly funded cart road failed. Their provisions were brought by boat from the adjacent island, Skye. In 1966 a crofter, Calum Macleod, literally took matters into his own hands. Calum had no experience of road-making. He began by buying a second-hand copy of Aitken's text. During the following ten years he wore out "two wheelbarrows, six picks, five hammers and four spades" to build a 3-metre wide road, 3 kilometres long comprising a layer of stone,

gleaned locally, much of which had to be broken by hand, surfaced with gravel and small stones (23, 24). In 1982 Calum's road became a public highway and £115,000 was spent widening and surfacing it.

Aitken's texts were the primary reference source for professional engineers in Britain until Edward Arnold & Company established their Roadmaker's Library series in the mid-1930s. Aitken's text was hardly cited in any of the series and when it was mentioned it was prefaced as the classic work. The best-selling of their texts was "Principles of Road Engineering" by Professor H. John Collins and C.A. Hart first published in 1936 (25). It cited extensively from American research on roads undertaken in the 1920s. In the early years of the 20th century it was America that sought road-making expertise from Europe.

8. THE THIRD STRAND – CONTINUED

In February 1908, Thomas Aitken made a special request to Fife County Council that he was "desirous for five or six months in the current year of having an Assistant so that he would be able to be absent from the County or otherwise occupied to the extent of about a day and a half in each week during that time and he proposed to employ an assistant whose remuneration would be at the rate of not more than £110 per annum and who would be in attendance in the office in Cupar in Mr. Aitken's absence as well as an assistant in the office work, which had now become of such amount as could scarcely be overtaken by the Surveyor without an assistant or a clerk, and Mr. Aitken stated that he is prepared to contribute to the remuneration of the assistant" (26). The council decided to pay up to half of the sum, i.e. £27.10s, for the services of an assistant to Mr. Aitken for a period not exceeding six months. Aitken's attempt in November 1908 to continue to employ an assistant failed

In the summer of 1908 Thomas Aitken travelled to the United States. Coleman duPont was a member of the American state of Delaware's leading industrial family, an automobile enthusiast, a leader in the U.S. Good Roads Movement, and serious student of roadways. He had travelled throughout Europe and the United States examining road design and construction technology. He offered to construct a visionary superhighway the length of the state of Delaware (27). He planned a multimodal highway design unlike anything that had ever been built. It would have had central lanes for high-speed automobiles, and flanking lanes for trolleys, heavy motor freight, horses and horse-drawn vehicles, and pedestrians. DuPont brought to Wilmington "two consulting engineers of international renown, Thomas Aitken from Scotland and Ernest Storms from Belgium".

The Boulevard Corporation Act, as passed by the Delaware General Assembly in 1911, authorised a corporation, known as Coleman duPont Road, Inc., to construct the highway the length of the state. As each section of ten miles was completed, it was to be conveyed to the state free of charge. DuPont himself was chief engineer. Construction began with the southernmost section in September 1911. Litigation interrupted construction from 1912 to 1915, but the first 20 miles of the road, from the Maryland Line near Selbyville to six miles south of Milford, was completed and presented to the state on May 24, 1917.

Although built to a smaller scale than originally proposed by duPont, the 2- lane concrete highway was still an example of one of the most modern highways in the U.S. at that time. It pioneered the bypass. The highway bypassed towns and was connected to them through spur roads. At first the public thought the idea ridiculous, and worried that it would hurt business. After its execution, the bypass idea took root in the highway department, which said in a 1920 report that "in many instances it is better to have the trunk roads laid out near the towns rather than through the towns" because of concerns for safety and traffic congestion. The highway was so successful as a trunk line for Delaware's rapidly increasing motor traffic, that it soon became overburdened. The widening of what is now U.S.Route 113, began as early as three years following its completion.

9. THE PUBLIC INTEREST

On his return to Fife in September 1908 the Surveyor's official response to damage to property arising from tar-spraying in a village was "that the work of tarring the road was done by contract with the Taroads Syndicate Ltd. And suggested that the letter be forwarded to that syndicate (which was done), with the request that it be dealt with, and nothing further has been heard on the subject" (26). Aitken's personal involvement in the syndicate was no secret, but was not acknowledged in any official documents in Fife. Surface-spraying of roads with tar was credited in the Council's records in May 1909 "of forming "in-situ" Tarmacadam (which) has proved very successful and has been greatly appreciated by those residing in houses adjoining the highway, further work of this nature will be carried out over this summer more particularly in villages through which much wheel traffic passes".

Throughout the period from 1906 until 1910 Aitken continued to publish a series of articles on his system, which was intended to meet the requirements of the highway authorities in Britain to both preserve roads and prevent dust as motor-traffic increased (28-34).

Aitken's annual report to the County Council in 1912 noted that "vehicular traffic is still on the increase, necessitating the application of larger quantities of metalling and the employment of additional labour" (35). He continued "the surface spraying of certain roads with prepared tar has had good effects, and has been greatly appreciated by the occupiers of houses situated near the highways and by travellers generally. It is very noticeable where roads are so treated that the number of pot-holes, caused principally by motor-cars, are practically non-existent compared with untreated portions of roads adjoining. The grant provided by the Imperial Road Board will be principally allocated to making tar-macadam through the villages situated on the "selected routes" and also for surface spraying at different places". At that time Aitken's annual salary as the Road Surveyor was £325.

The Great War had already begun when permission was finally given for the appointment of an Assistant Road Surveyor at an annual salary not exceeding £100 per annum to be paid monthly. In October 1914 the Council members voted whether to appoint William Lindsay who sought £90 per annum or William Boyd who settled for £80 in addition to an annual allowance of £3 "for the maintenance of a bicycle" (35). The vote was 3 to 4 in favour of Boyd.

10. CONSIDERABLE DIFFICULTIES

However the conflicts of interest apparent between Aitken's 1st and 4th strands were becoming more obvious. Lessons about such conflicts, which had been learned in other public works over the previous century, were being learned in Fife (36). In July 1915 the County's Treasurer reported that there were "considerable difficulties in passing accounts incurred to the Taroads Syndicate, certified by the Road Surveyor" (35). The contracts that the Syndicate was awarded had been offered in competition but other contractors seldom submitted bids and if they did they were always undercut.

The Great War also began to intrude. In October 1915, Lord Derby was appointed Director-General of Recruiting. He brought forward a scheme, known as the Derby Scheme for raising the numbers of recruits. It was half-way to conscription. That December, the Assistant Surveyor, William Boyd, was granted an allowance of £2 per month for six months by the Council for joining the army under the Derby Scheme. In the event Boyd's allowance was renewed for four further six-month periods and he was never to work for Thomas Aitken again. At the same meeting Aitken reported that 12 of his roadmen were eligible for military service, but requested that his foremen be exempted from military service on account of their skills being as valuable as munitions workers at home (35). By the end of 1916 Aitken reported that following a further request by the "Imperial Road Board" he had no more men to send to the front.

In early 1916 Aitken received permission for a female clerk to take Boyd's place temporarily at a salary not exceeding £32 per annum paid weekly. This post was taken up by Aitken's 26-years old daughter, Margaret. The Great War took its toll as roads were damaged by the traction engines used to haul off the rapidly depleting woodlands of the county and a Fife quarryman who had joined the Roads Construction Company in France died on October 1917. William Boyd was convalescing after injuries at the front, when on 27 May 1918 Thomas Aitken died.

11. SYMPATHETIC REFERENCE

The local newspaper, *"The Fife Herald & Journal"* reported "in the death at Banchory on Monday afternoon of Mr. Thomas Aitken, there passed away an official of long standing in the county of Fife and of wide reputation in his profession as a road surveyor. To the efficiency with which he carried out his work as road surveyor frequent testimony has been borne. In an article in the 'Fortnightly' some years ago a stranger on a cycling tour told the present writer that in all the counties he had visited he had not come across roads equal to those in Fife" (37).

The paper gave a brief outline of his career including a reference to the formation of the Taroads Syndicate, Glasgow, "with Mr. Aitken as managing director. He subsequently formed a small company for the purpose of working the (tar spraying) machine and accomplished a great deal with it, particularly in the west of Scotland." *"The Fife Herald & Journal"* rounded off its tribute with "A family bereavement that told perceptibly on Mr. Aitken's health was the loss of his younger son, James, who after going through the Gallipoli campaign died of fever in a hospital at Amara, near the Persian Gulf. Mr. Aitken is survived by a son and daughter."

On 4 June 1918 a special committee meeting was called "for the purposes of considering what arrangements should be made by the Council for carrying on the work on the roads following the death of the Surveyor, Mr.Aitken" (35). The whole question was fully discussed and it was ultimately resolved that Mr. George Strachan be asked to supervise the work on the roads in the same way he acted for Mr. Aitken. Mr. Strachan was to be allowed his out-of-pocket expenses

and to be given an honorarium when the arrangement with him terminates. It was further resolved to recommend Mr. Boyd be continued as Assistant Road Surveyor and that his salary be increased to £160 per annum."

Aitken's daughter was asked whether she wished to remain on her then salary of £45, but she resigned. It was soon learned that Margaret Aitken had removed various plans and other articles from the Council's office and contended that these had belonged to her father. The Committee believed that the plans were not his property and began formal procedures to recover them. At the same meeting the Assistant Surveyor was authorised to procure any necessary drawing materials required by him and was asked to make an inventory of what remained in the office (35). It was also agreed that arrangements should be made to purchase from "Mr. Aitken's representatives" the engineering level that had been used by him.

In July Major Lawson of Annfield, chairman of the Cupar District of the Council "made sympathetic reference to the death of the late road surveyor of the district, Mr. T. Aitken. He was an enthusiast in his profession and had given very great service to the Committee. He moved that they record their senses of loss in the minutes and send an excerpt to Mrs. Aitken" (38).

12. BACK TO THE USA

In September a motor cycle was provided for the use of the Assistant Road Surveyor at a cost of £48 (35). On 1 April 1919 William Boyd's contract as Road Surveyor was confirmed at a salary of £250 per year rising at £20 per year to a maximum of £400, but he was not allowed to undertake work for anyone else.

Boyd was still the County Road Surveyor for Fife when he took ill and died on 18 July 1952 (39). His successor, Tom McCallum, was a member of the County Surveyors' Society team which visited the United States to study the place of motorways in their transport system (40). McCallum later recommended one of Boyd's sons, also called William, become the Resident Engineer for Fife's first motorway, the M90, which was completed in 1970 (41).

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